

Structured Questions: Paper 2

1.4 Cells: Division

1.4.1 Cell Cycle / 1.4.2 Phases of Mitosis / 1.4.3 Cancer / 1.4.4 Skills: Cell Division

Easy (5 questions)	/44
Medium (5 questions)	/51
Hard (5 questions)	/49
Total Marks	/144

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Easy Questions

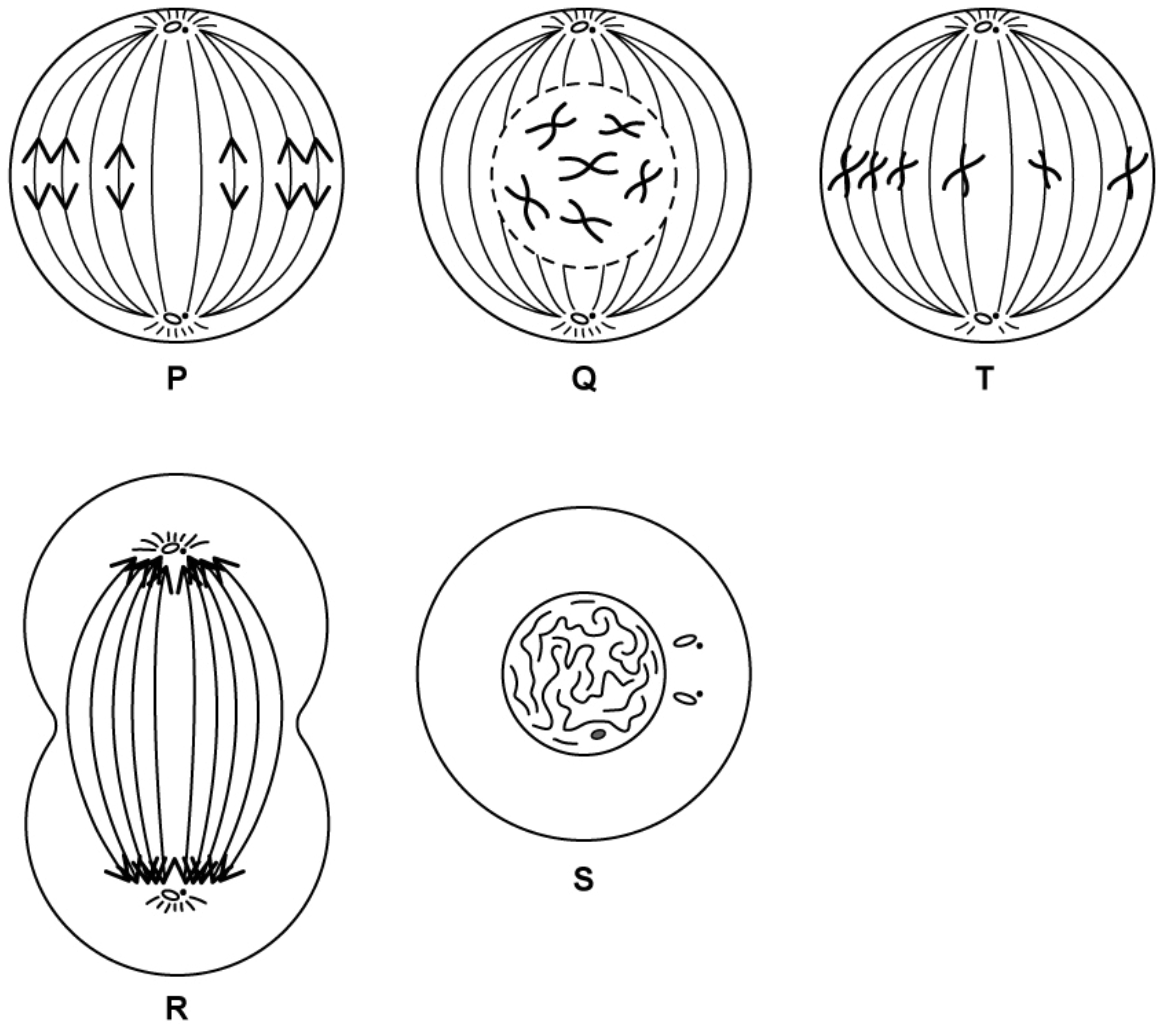
1 (a) State which structure is formed in animal cells by the pinching of the plasma membrane during cytokinesis.

.....
(1 mark)

(b) Define mitosis.

.....
.....
(2 marks)

(c) The drawings below show a cell during different stages of mitosis.



List the stages **P**, **Q**, **R**, **S** and **T** in the correct sequence.

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(3 marks)

(d) Cell **M** contains 74 chromosomes. It divides by mitosis.

State how many chromosomes the daughter cells will contain.

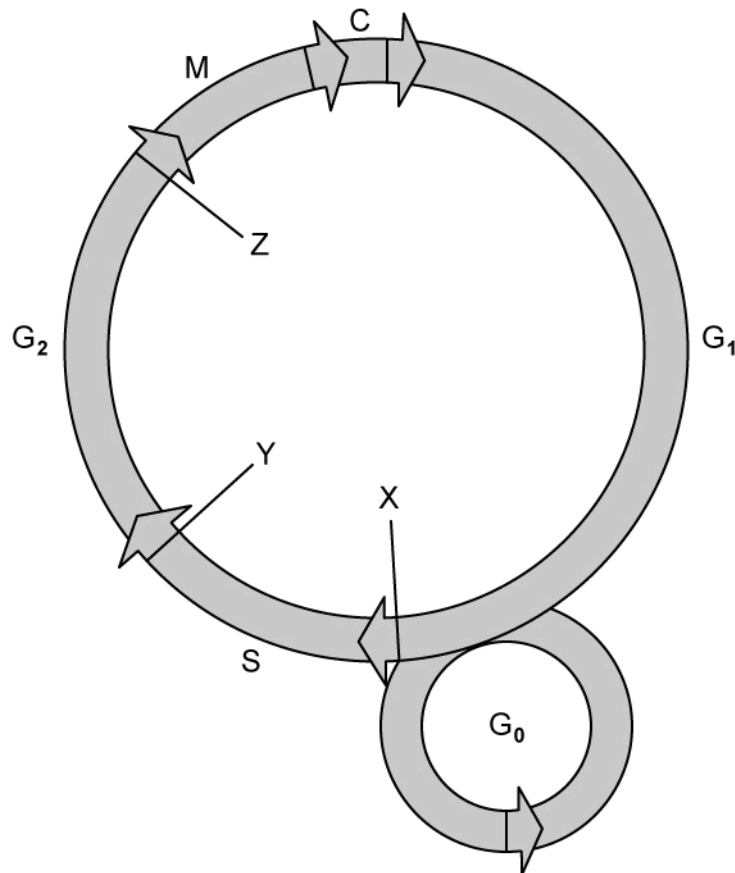
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(1 mark)

2 (a) State which proteins are used to control the cell cycle.

(1 mark)

(b) The diagram below represents the different phases of the cell cycle.



State **all** the letters in the diagram that represent the phases of interphase.

(1 mark)

(c) The tumour suppressor gene TP53 codes for a protein that interrupts the cell cycle if there is any damage to the DNA and prevents the copying of damaged DNA.

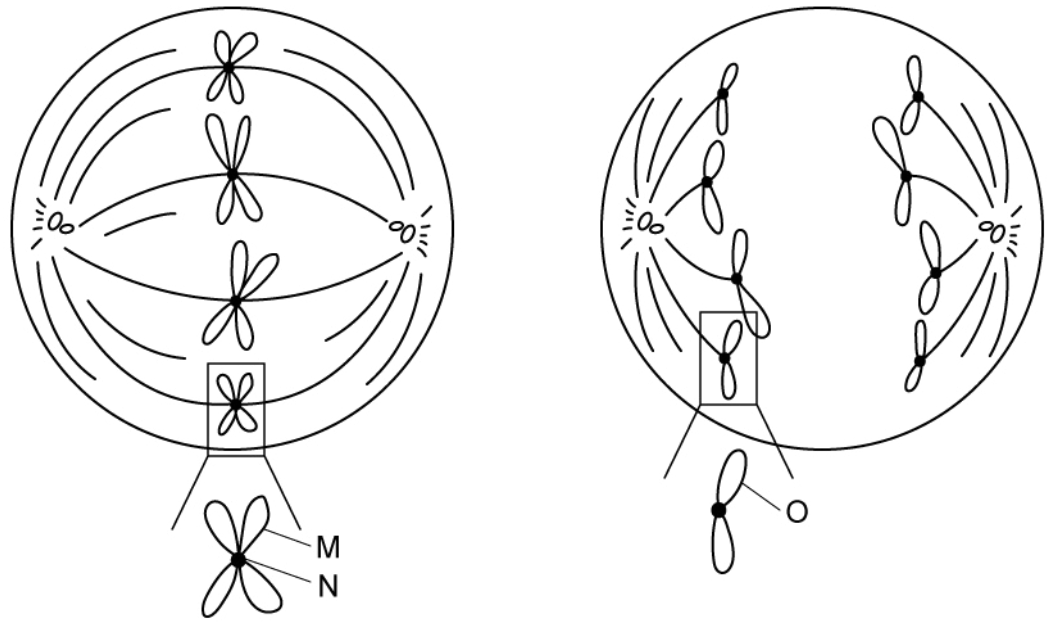
State which stage of the cell cycle this gene would interrupt.

(1 mark)

(d) Define oncogene.

(2 marks)

3 (a) The diagram below shows two different stages of mitosis.



Identify structures **M**, **N** and **O**.

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(3 marks)

(b) List three reasons why cells will undergo mitosis.

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(3 marks)

(c) State the process that occurs during prophase that enables chromosomes to condense.

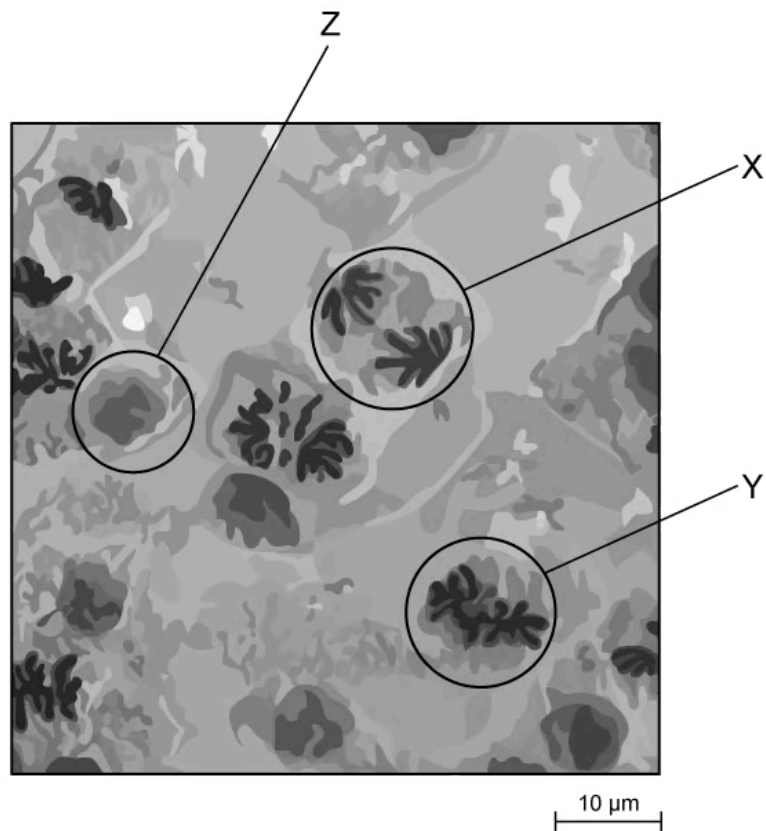
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(1 mark)

(d) List **four** examples of mutagens.

(2 marks)

4 (a) The diagram below shows some grasshopper cells.



State the stages of the cell cycle shown by X and Y.

.....

.....

(2 marks)

(b) Outline the events occurring during the stage shown as Z in part (a).

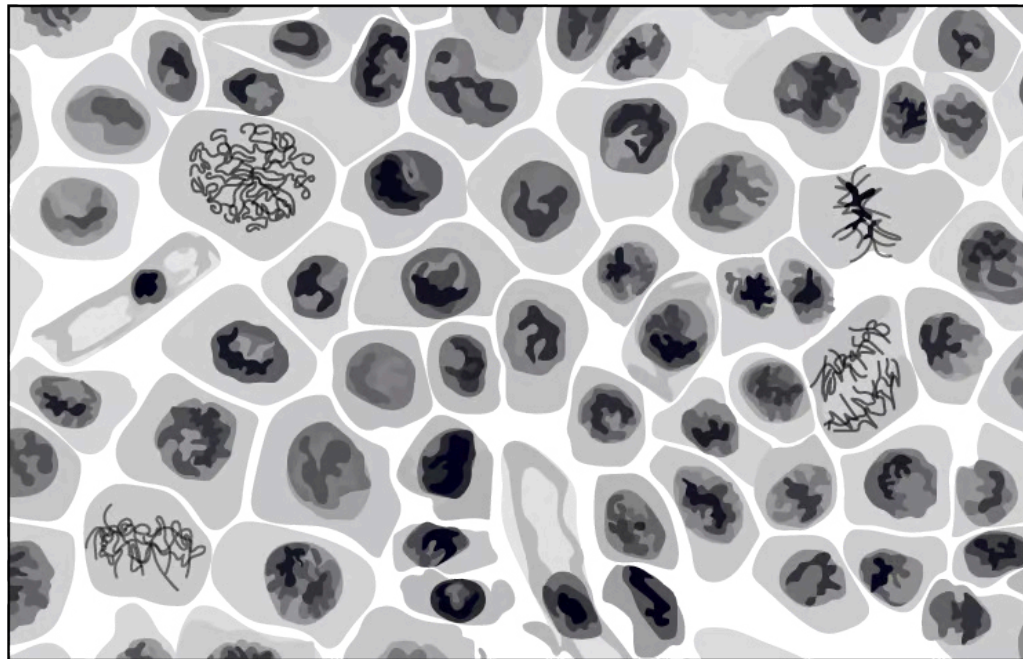
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(3 marks)

(c) The diagram below shows onion cells from the root tip.



50 μm

Calculate the mitotic index for this root tip.

(2 marks)

(d) Doctors use the mitotic index when examining tumours.

Suggest what a high mitotic index would indicate to a doctor.

(1 mark)

5 (a) *One mark is available for clarity of communication throughout this question.*

Outline how the role of cyclins in the cell cycle was discovered.

(3 marks)

(b) Budding yeast cells complete a cell cycle in 90 minutes.

Outline the stages in the cell cycle that result in the development of new yeast cells.

(6 marks)

(c) Compare and contrast cell division of prokaryotic and eukaryotic cells.

(6 marks)

Medium Questions

1 (a) Distinguish between the terms chromosome and chromatid.

(3 marks)

(b) A student writes the statements below describing the different stages in mitosis but is missing some information.

Stage 1: Chromosomes become shorter and thicker, and the nuclear membrane breaks down.

Stage 2: Chromosomes line up along the equator of the cell and __(i)__,

Stage 3: __(ii)__, causing the chromatids to separate and move towards __(iii)__.

Stage 4: A new nuclear membrane forms around each group of chromosomes.

Complete **Stage 2** and **Stage 3** with an appropriate statement / statements.

(3 marks)

- (c) The mitotic index is a measure of the proliferation status of a cell population (i.e. the proportion of dividing cells).

A student prepared a root tip squash and observed the cells under a microscope. A total of 147 cells were observed and 95 of these cells were observed in various stages of mitosis.

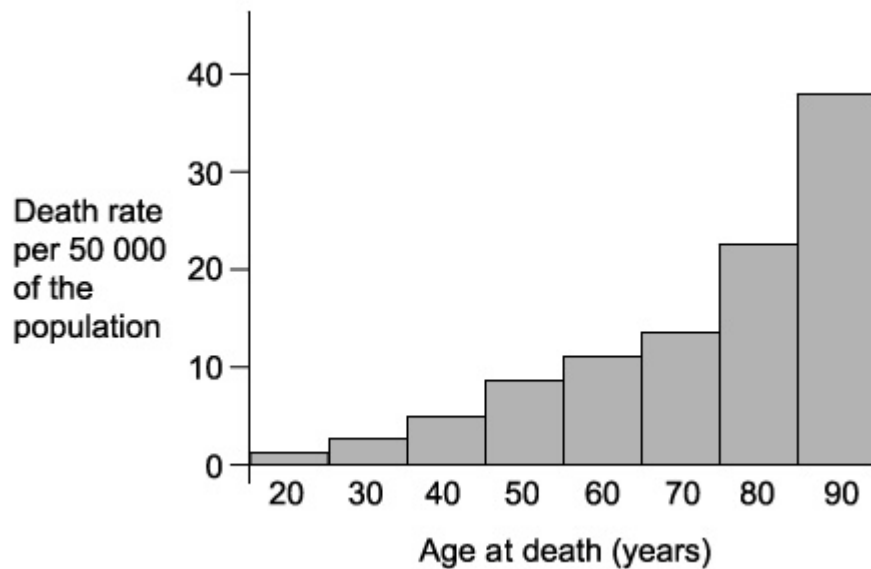
- (i) Calculate the mitotic index for this dividing root tissue.

The teacher wanted to double-check this. The student had counted the total number of cells correctly but the teacher calculated a mitotic index of 0.81.

- (ii) Calculate the number of cells undergoing mitosis that the teacher observed.

(2 marks)

- 2 (a) The death rate from brain cancer was investigated in the UK. The graph below shows the results for women in different age groups.



Suggest a possible explanation for the relationship seen in the graph above.

.....
(1 mark)

- (b) Melanoma is a type of skin cancer that develops from pigment-producing cells in the skin known as melanocytes. Some people who spend too much time sunbathing develop melanoma.

Explain why.

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(2 marks)

- (c) There are two main forms of tumours (one being benign tumours).

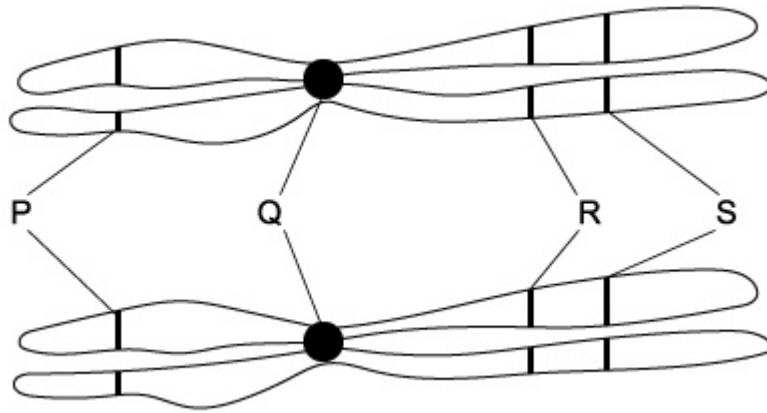
State the other main form of tumour and outline **two** ways in which a benign tumour differs from the other main form of tumour.

(3 marks)

(d) Describe **two** ways in which both types of tumour may cause harm to the body.

(2 marks)

3 (a) The diagram below shows two chromosomes in a cell undergoing mitosis.



Identify structure **Q** and explain what happens to it during anaphase.

.....

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(2 marks)

(b) After looking at the diagram in part (a), a scientist concludes that the two chromosomes are homologous.

Use the diagram in part (a) to explain why the scientist has come to this conclusion.

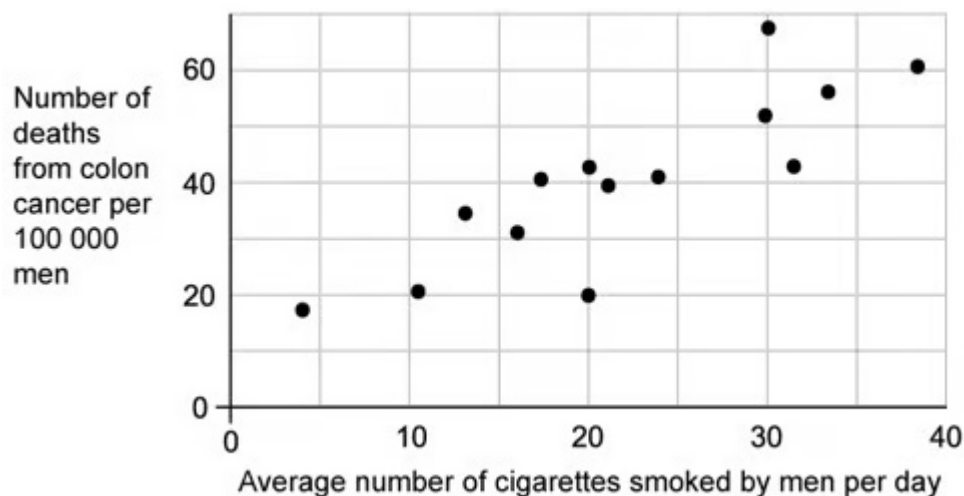
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(2 marks)

(c) A group of researchers investigated the relationship between the average number of cigarettes smoked by men per day and the number of men dying from colon cancer in

14 different countries. The data from the study is provided in the graph below.



A website reported the results of this investigation using the headline 'Smoking causes cancer'.

Explain why the researchers could not support this view based on the results of their investigation alone.

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(4 marks)

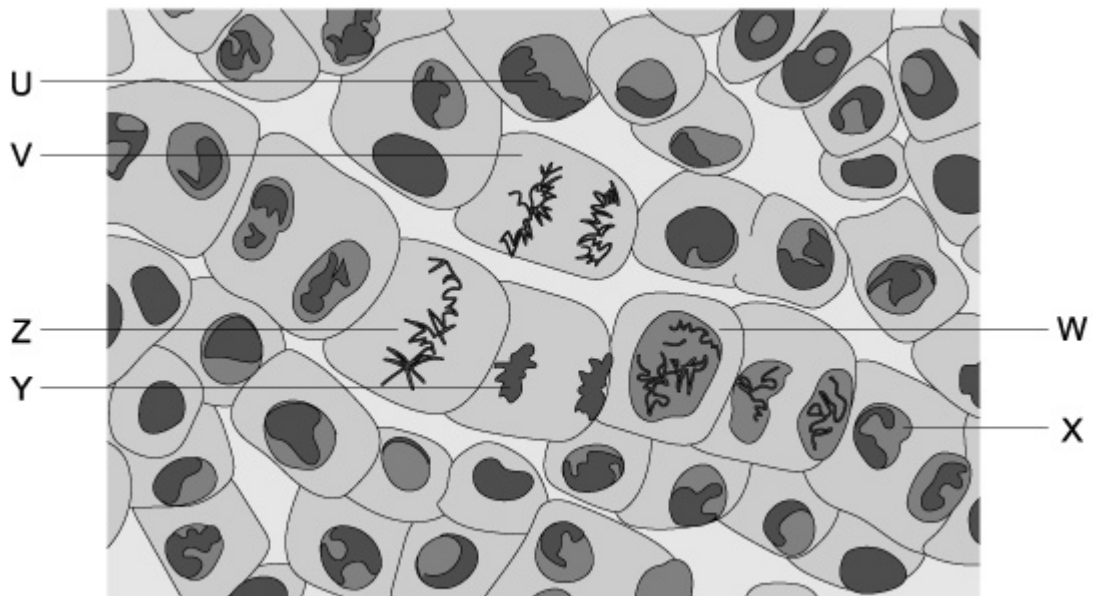
(d) Explain why the death rate from colon cancer in part **(c)** is given per 100 000 men and not given as the total number of deaths.

.....

.....

(2 marks)

- 4 (a) The drawing below shows a micrograph of actively dividing cells in the tissue taken from the tip of a plant root.



Using the micrograph drawing above, complete the table.

Cell	Name of the stage of cell division
W	
V	
Z	

.....

.....

.....

(3 marks)

- (b) In which of the cells (U, V, W, X, Y or Z) in the micrograph drawing in part (a) can vesicles now fuse to form new cell membranes across the cytoplasm (in order to separate the cell into two daughter cells).

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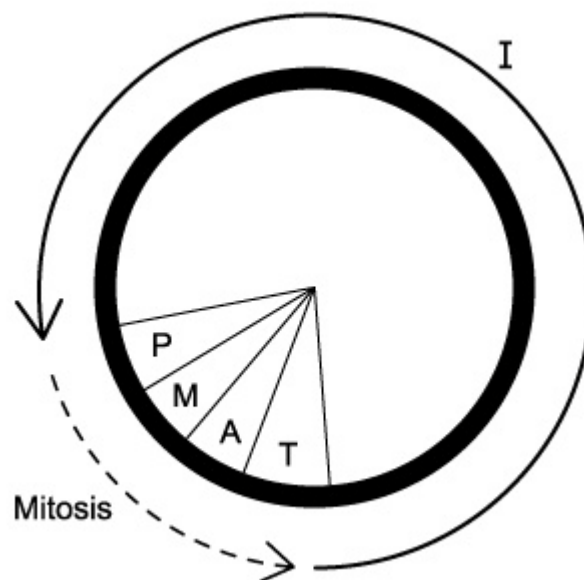
(1 mark)

(c) Tumour-suppressing genes are a type of gene that controls cell division.

Identify the other type of gene, then explain how it controls cell division and why a mutation in this type of gene can lead to cancer.

(4 marks)

(d) The diagram below shows a cell cycle.



Explain what occurs during the part of the cell cycle labelled **I**.

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Describe what happens during cytokinesis in animal cells and plant cells.

(3 marks)

(b) Explain how the cell cycle is controlled.

(5 marks)

(c) Describe the events that take place during mitosis, including the name of the stage of mitosis during which each event occurs.

(7 marks)

Hard Questions

- 1 (a) Bowel cancer can result from adenoma polyps. Adenoma polyps form as a result of mutations occurring in dividing cells of the colon lining.

Suggest the differences in the cell cycle of a cancer cell compared with that of a normal intestinal cell.

.....

.....

(2 marks)

- (b) Compare and contrast the process of cytokinesis in plants and animals.

.....

.....

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(3 marks)

- (c) Before the cell progresses from G_1 into S phase, it needs to pass through a checkpoint, which prevents the cell cycle from proceeding if certain conditions are not met.

Suggest one reason why a cell might not progress through the checkpoint.

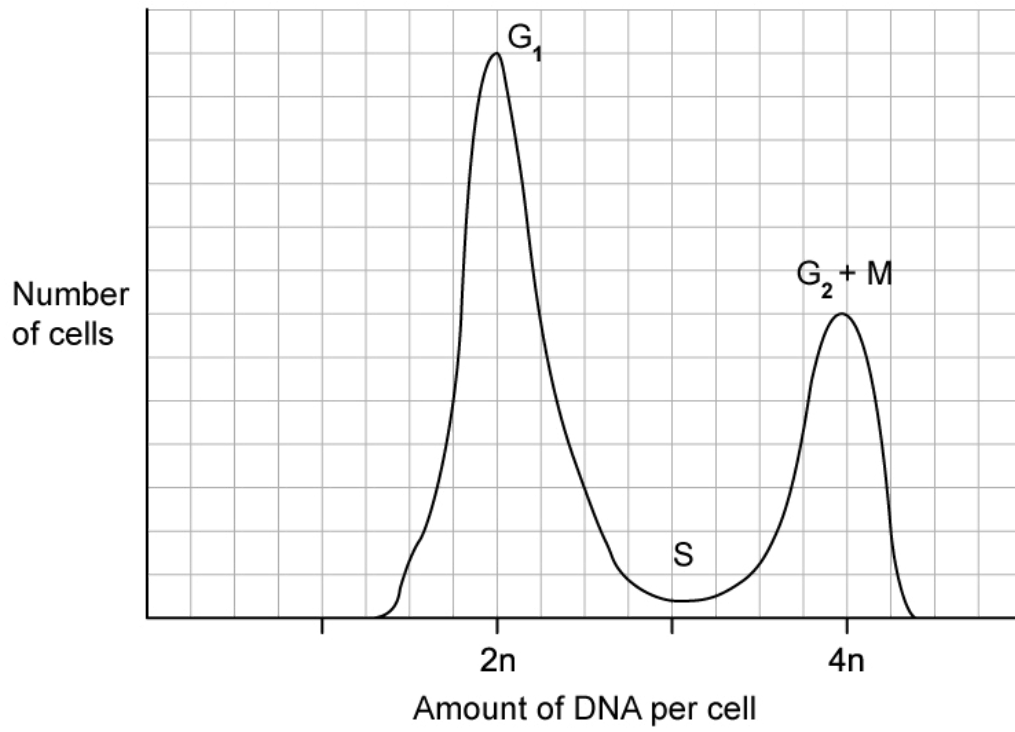
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(2 marks)

- (d) The graph below shows data produced from a flow cytometer. This measures the number of cells that are labelled with DNA bound to a fluorescent dye, as this is proportional to DNA content. The stages of the cell cycle are indicated.

Suggest why, during the S phase, that the amount of DNA per cell is between $2n$ and $4n$.



(2 marks)

2 (a) During the cell cycle, there are various checkpoints the cell meets to determine if there are any errors. If an error cannot be repaired then the cell goes through cell death (apoptosis).

Scientists have developed cancer drugs that can inhibit the cell cycle and cause the cell to carry out apoptosis. **Paclitaxel** and **5-fluorouracil** are two of these cancer drugs.

- **Paclitaxel** binds to spindle microtubules preventing the spindle from performing its function
- **5-fluorouracil** prevents the synthesis of thymine nucleotides

Determine at which stages of the cell cycle these drugs would take effect and inhibit the cell cycle.

(2 marks)

(b) Discuss the role serendipity plays in scientific discoveries, using a named example.

(3 marks)

(c) Sketch a graph to illustrate which cyclin is controlling the different phases of the cell cycle.

(3 marks)

- (d) In order to identify which phase of the cycle a cell is in, other than mitosis, biochemical analysis is used. Radioactive thymidine is one example of a biochemical used.

Suggest, giving a reason, which phase is readily identified when radioactive thymidine is used.

(2 marks)

- 3 (a)** A team of biologists estimated the number of cells in different phases of the cell cycle in *Saccharomyces cerevisiae* (brewer's yeast). They took two samples, **A** and **B**, from different environmental conditions. One sample came from a nutrient-rich environment, the other from a nutrient-poor environment.

Their results are shown in the table below.

Phase of the cell cycle	Sample A / number of cells counted	Sample B / number of cells counted
G ₁	312	451
S	203	294
G ₂	136	196
Mitosis	27	39
Total	678	980

In sample **A**, a full cell cycle took 1 hour and 35 minutes, whereas, in sample **B**, a full cell cycle took 60 minutes.

Calculate the time, in minutes, that the cells in sample **A** were in S phase during one cycle. Show your working.

.....

.....
(2 marks)

- (b)** The biologists studying the *Saccharomyces cerevisiae* (brewer's yeast) from part (a) hypothesised that when the yeast was exposed to stressful conditions, the growth rates were low.

Suggest, with a reason, which sample came from the nutrient-rich conditions.

.....

(2 marks)

- (c) The availability of nutrients is also a key factor in regulating the cell cycle of *Schizosaccharomyces pombe* (fission yeast). Below is a table containing data scientists collected for two sites which were deficient in nitrogen and phosphate.

Phase of the cell cycle	Deficient in nitrogen / number of cells counted	Deficient in phosphate / number of cells counted
G ₁	207	181
S	135	118
G ₂	90	79
Mitosis	0	0
Total	432	378

Deduce, giving a reason, the point at which a nutrient-poor environment would arrest the cell cycle of the *Schizosaccharomyces pombe*.

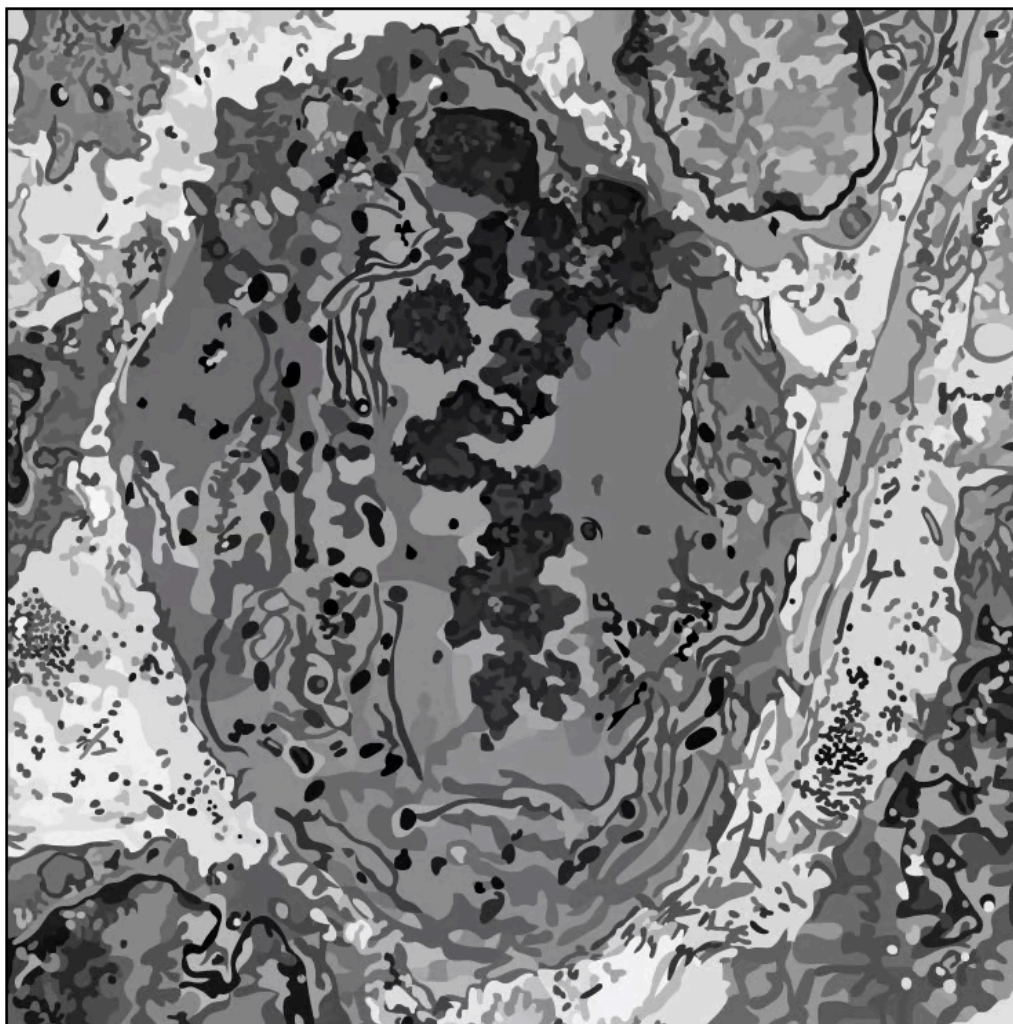
(2 marks)

- (d) The *Saccharomyces cerevisiae* (brewer's yeast) nuclei are, on average, 2 µm in diameter, but the DNA molecules packed into them have been measured up to 355 µm in length.

Describe the process that enables the DNA molecules, that comprise the 16 chromosomes of yeast, to be packed into the nuclei.

(2 marks)

- 4 (a) The diagram below shows a drawing of an electron micrograph of a cell undergoing mitosis.



Deduce which phase of mitosis this cell is in.

(1 mark)

- (b) The diagram below shows a sample of root tissue collected by a researcher.



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Calculate the mitotic index.

(2 marks)

- (c) A student's research determined that the cell cycle of the growing tissue in a similar root as part (b) was 1,560 minutes in length, and that on average, cells spent 5 hours in the visible stages of mitosis.

Calculate the percentage difference between the data gathered by the student and the mean length of the mitotic stages found by the researcher in part (b).

(2 marks)

- (d) Suggest **two** possible reasons why there may have been differences in the mitotic index the researcher determined and the student's value.

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

MPXV is a virus that belongs in the same group as smallpox and cowpox.

Explain why viruses, such as MPXV, do not have a cell cycle.

(4 marks)

(b) Some cell biologists believe that the use of the term 'cell division' should be discontinued and replaced with 'cell multiplication'.

Evaluate this claim using your knowledge of the cell cycle.

(5 marks)

(c) *Human papillomaviruses* are the main cause of cervical cancer.

Explain how mutagens can interrupt the cell cycle to cause cancer.

(6 marks)